CHAPTER

PERIODIC TABLE AND PERIODICITY OF PROPERTIES

MULTIPLE CHOICE QUESTIONS

1. **Shielding effect is greater in atoms with greater number of:**
   (a) protons (b) Neutrons (c) electrons (d) positrons

2. **There are total ____ groups and _____ periods in the modern periodic table:**
   (a) seven, eight (b) eighteen, seven (c) eight, seventeen (d) sixteen, eight

3. **If we move from left to right in a period, the value of ionization energy:**
   (a) remain same (b) decreases (c) increases (d) not effected

4. **The ionization energy of sodium valence shell electron:**
   (a) +495.8 kj/mol (b) +594.8 kj/mol (c) -495.8 kj/mol (d) -594.8 kj/mol

5. **It is the amount of energy related when an electron is added up in the outermost shell of an isolated gaseous atom:**
   (a) shielding effect (b) electron affinity (c) electro negativity (d) ionization energy

6. **Salt of sodium give:**
   (a) bluish green (b) red (c) yellow (d) green

7. **The half of distance between the nuclei of the two bonded atoms referred as the:**
   (a) atomic size (b) radius (c) ionic radii (d) common size

8. **Sixth and seventh periods are called:**
   (a) short period (b) normal period (c) long period (d) very long period

9. **The d-block elements lie between the blocks:**
   (a) s-p (b) d-f (c) p-s (d) f-d

10. **Which one of the halogen has the highest electro-negativity?**
    (a) bromine (b) iodine (c) chlorine (d) fluorine

11. **The shielding effect of the inner electrons is responsible for:**
    (a) increasing ionization energy value (b) decreasing ionization energy value
    (c) increasing electron affinity (d) increasing electronegativity

12. **According to the modern periodic law, the properties of the elements are periodic function of their:**
    (a) atomic number (b) number of electrons
    (c) mass number (d) number of valence electrons

13. **Which is the best reason for increasing of ionization energy from left to right in a period?**
(a) the shielding effect remains the same (b) the nuclear chare increases
(c) the number of inner electrons increases (d) increasing electronegativity

14. **Units of ionization energy are:**
(a) kj/mol (b) kj/mol (c) kj (d) j/mol

15. **5-f series of inner transition elements are called:**
(a) Lanthanides (b) Actinoids (c) Halogens (d) Alkali metals

16. **Halogen belongs to group:**
(a) 17 (b) 16 (c) 18 (d) 32

17. **How many elements are there in 4th period:**
(a) 7 (b) 8 (c) 18 (d) 32

18. **Which is the incomplete period in the periodic table?**
(a) fourth period (b) second period (c) seventh period (d) first period

19. **Which scientist had given the idea of octaves in periodic table?**
(a) Mendeleev (b) al-razi (c) Newland (d) Dobereiner

ANSWER KEY

1	c	4	a	7	d	10	b	13	a	16	c
2	b	5	b	8	a	11	a	14	a	17	c
3	c	6	a	9	d	12	b	15	b	18	c

SHORT QUESTIONS

3.1 PERIODIC TABLE

Q.1 What was the contribution of Dobereiner towards classification of elements?

Ans. A German chemist Dobereiner observed relationship between atomic masses of several groups of three elements called triads. In these groups the central or middle element had atomic mass average of the other two elements. only a few elements could be arranged in this way. This classification did not get wide acceptance.

Q.2 How Newlands arranged the elements?

Ans. Newlands put forward his observations in the form of 'law of octaves'. He noted that there was a repetition in chemical properties of every eight element if they were arranged by their increasing atomic masses He compared it with musical notes.

Q.3 Who introduced the name Periodic Table?

Ans. Russian chemist, Mendeleev arranged the known elements (only 63) in order of increasing atomic masses, in horizontal rows called periods. So that elements with similar properties were in the same vertical columns. This arrangement of elements was called periodic table. He put forward the results of his work in the form of periodic law.

Q.4 Why the improvement in Mendeleev's periodic table was made?

Ans. His failure to explain the position of isotopes and wrong order of the atomic masses of some elements suggested that atomic mass of an element cannot serve as the basis for the arrangement of elements.

Q.5 State Mendeleev's periodic law.

Ans. Properties of the elements are periodic functions of their atomic masses.

Q.6 Why and how elements are arranged in a period?

Ans. Because the atomic number or nuclear charge increases by one electron consecutively and show periodicity from left to right. Repetition of the properties of element with the regular interval is called periodicity. The horizontal rows are called periods in periodic table that is arranged on the bases of electronic configuration.

MODERN PERIODIC TABLE

Q.1 How the properties of elements repeat after regular intervals?

Ans. The significance of atomic number in the arrangement of elements in the modern periodic table lies in the fact that as electronic configuration is based atomic number, so the arrangement of elements according to increasing atomic number shows the periodicity (repetition of properties after regular intervals) in the electronic configuration of the elements that leads to periodicity in their properties.

Q.2 In which pattern modem periodic table was arranged?

Ans. The horizontal rows of elements in the periodic table are called periods. The vertical columns in the periodic table are called groups. Modern periodic table was arranged on basis of electronic configuration.

Q.3 How many elements are in first period and what are their names and symbols?

Ans. There are two elements in first period of the modern periodic table which are hydrogen and helium. The symbol of hydrogen is 'H' and helium is 'He'?

Q.4 How many elements are placed in 4th period?

Ans. There are eighteen elements are placed in fourth period of modern period table.

Q.5 From which element lanthanide series starts?

Ans. Lanthanide series starts from the element lanthanum (La).

Q.6 From which period actinides series starts?

Ans. Actinides series starts from the element actinium (Ac) 7^{th} period.

Q.7 How many elements are in 3rd period, write their names and symbols?

Ans. There are eight elements are placed in 3rd period of modern period table which are sodium (Na), magnesium (Mg), aluminum (Al), Silicon (Si), phosphorus (P), sulphur (S), chlorine(Cl) and argon (Ar).

Q.8 How many periods are considered normal periods?

Ans. There are three periods considered as a normal periods which are 1st , 2nd and third.

Q.9 What do you mean by a group in a periodic table?

Ans. The horizontal rows of elements in the periodic table are called periods.

Q.10 What is the reason of arranging elements in a group?

Ans. The vertical columns in the periodic table are called groups.

Q.11 What do you mean by periodic function?

Ans. Properties of the elements are periodic function of their atomic numbers and periodic function means the elements repeat their properties according to increasing atomic number in periods of periodic table.

Q.12 Why the elements are called s or p block elements?

Ans. Because electronic configuration of elements remain incomplete in s-subshell called as s-block elements and if electronic configuration of elements in remain incomplete in p-subshell called as p-block element.

Q.13 Write down the names of elements of group 1 with their symbols?

Ans. Hydrogen (H), Lithium (Li), Sodium (Na), Potassium (K), Rubidium (Rb), Cesium (Cs) and Fransium (Fr).

Q.14 How many members are in group 17, is there any liquid, what is its name?

Ans. There are five elements in group 17 called halogens named as fluorine (F), Chlorine (Cl), bromine (Br), iodine (I) and astatine (At). Bromine is found in liquid state.

3.2 PERIODICITY OF PROPERTIES

Q.1 How can you define atomic radius?

Ans. The half of the distance between the nuclei of the two bonded atoms is referred as the atomic radius of the atom.

Q.2 What are SI units of atomic radius?

Ans. Pico meter (pm) = 10^{-12}

Nano meter (nm) = 10^{-9}

Q.3 Why the size of atoms decreases in a period?

Ans. When we move from left to right in a period although atomic number increases, yet the size of atoms decreases graduall . It is because with the increase of atomic number, the effective nuclear charge increases gradually because of addition of more and more protons in the nucleus.

Q.4 Define ionization energy.

Ans. The ionization energy is the amount of anergy required to remove the most loosely bound electron from the valence shell of an isolated gaseous atom.

Q.5 Why the 2nd ionization energy of an elements is higher than first one?

Ans. The energy required to remove an electron from an isolated monopositive gaseous ion (M+) is called second ionization energy.

So, more energy is required to remove 2nd electron from a monopositive gaseous ion because there is more electrostatic force present between the nuclei and electron.

$$M^{+}_{(g)} \longrightarrow M^{+}_{(g)} + e^{-}$$

Q.6 What is trend of ionization energy in a group?

Ans. As we move down the group more and more shells lie between the valence shell and the nucleus of the atom, these additional shells reduce the electrostatic force felt by the electrons present in the outermost shell. Resultantly the valence shell electrons can be taken away easily.

Q.7 Why the ionization energy of sodium is less than that of magnesium?

Ans. The ionization energy of sodium is less than the magnesium because sodium has one electron, in its valence shell, while magnesium has two electrons in its valence shell, so, there is more electrostatic force between the electrons of "Mg" with nucleus as compare to one electrons of sodium.

Q.8 Why is it difficult to remove an electron from halogens?

Ans. it is difficult to remove an electron from halogens because, they have seven electrons in their valence shell. The high ionization energy is required to remove an electron from their valence shell.

Q.9 What is shielding effect?

Ans. The effect of decrease in force of attraction between the nucleus and the valence electrons due to increasing number of inner shells or inner shell electrons between them ins called shielding effect.

Q.10 How does shielding effect decrease the forces of electrostatic attractions between nucleus and outermost electrons?

Ans. The electrons present between the nucleus and the outermost shell of an atom, reduce the nuclear charge felt by the electrons present in the outermost shell. The attraction of outer electrons towards nucleus is partially reduced because of inner electrons. As a result an atom experiences less nuclear charge than that of the actual charge, which is called effective nuclear charge (Z_{eff}).

Q.11 Why does the bigger size atoms have more shielding effect?

Ans. In bigger size atoms the number of inner shells and inner shell electrons increases hence the shielding effect of bigger size molecules also increases.

Q.12 Why does the trend of electron affinity and electro negativity is same in a period?

Ans. From left to right electron affinity and electronegativity increases because when the size of atom decreases the attraction of nucleus for electrons also increases. It means the more nuclear force on electrons the more energy is required. Therefore, electronegativity values also increases from left is right in the periodic table.

Q.13 Which element has the highest electronegativity?

Ans. Fluorine (F) atom has the highest electronegativity value among all the elements. It has value of electronegativity is 4.00.

SHORT QUESTIONS

Q.1 Why noble gases are not reactive?

Ans: Noble gases are not reactive because noble gases have eight electrons in their valence shells. So, they do not react with other elements. If elements do not have eight electrons in their valence shells they become reactive and by gaining or losing of electrons make them stable. But noble gases are not reactive.

Q.2 Why Cesium (at.no.55) requires little energy to release its one electron present in the outermost shell?

Cesium requires less energy to release its outermost electron because this electron is far away from nucleus. Hence, its ionization energy is very low. Because of large distance between nucleus and outermost shell it loses its electron easily.

Q.3 How is periodicity of properties dependent upon number of protons in an atom?

Ans: In periodic table, from left to right proton number increases in nucleus. Hence, nuclear charge will also change.

Q.4 Why shielding effect of electrons makes cation formation easy?

Ans: The decrease in the attractive force exerted by the nucleus on the valence shell electrons due to the presence of the electrons lying between the nucleus and valence-shell, is called shielding effect. When an element lose its one electron then its shielding effect will also increases. That's why, it loses its valence shell easily and became a cation.

Q.5 What is the difference between Mendeleev's periodic law and modem periodic law?

Ans:

Mendeleevs periodic law	Modern periodic law
Properties of the elements are periodic function of their atomic masses.	Properties of the elements are periodic function of their atomic numbers.
Atomic masses is the basic property of his law.	Atomic number is the basic property of modern periodic law.

Q.6 What do you mean by groups and periods in a Periodic Table?

Ans: The horizontal rows of elements in a periodic table are called periods. The vertical columns in a periods table are called group.

Q.7 Why and how are elements arranged in 4^{th} period?

Ans: Eight elements are present in 4th period. Their names are

Magnesium (Mg)
Aluminium (Al)
Silicon (Si)
Phosphorus (P)
Sulphur (S)
Chlorine (Cl)
Argon (Ar)

Q.8 Why the size of atom does not decrease regularly in a period?

Ans: From left to right atomic radius decreases in a periodic table. This change is not regular because shielding effect changes. If shielding effect decreases the size will also decreases.

Q.9 Give the trend of ionization energy in a period.

Ans: The ionization energy of elements increases as we go from left to right in a period.

LONG QUESTIONS

Q.1 Explain the contributions of Mendeleev for the arrangement of elements in a Periodic Table.

Ans: See Topic Mandleev's Periodic Table.

Q.2 Show why in a 'period' the size of an atom decreases if one moves from left to right.

Ans: See trend atomic size in periodic table.

Q.3 Describe the trends of electronegativity in a period and in a group.

Ans: See trend of electro negativity in Modern periodic table.

Q.4 Discuss the important features of modem Periodic Table.

Ans: See topic salient feature of periodic table.

Q.5 What do you mean by blocks in a periodic table and why elements were placed in blocks?

Ans: See the topic modern periodic table.

Q.6 Discuss in detail the periods in Periodic Table?

Ans: See the topic period in periodic table.

Q.7 Why and how elements are arranged in a Periodic Table?

Ans: See the topic periodic table.

Q.8 What is ionization energy? Describe its trend in the Periodic Table?

Ans: See the topic of ionization energy.

Q.9 Define electron affinity, why it increases in a period and decreases in a group in the Periodic Table.

Ans: See the topic electron infinity.

Q.10 Justify the statement, bigger size atoms have low ionization energy and have more shielding effect.

Ans: See the topic trend in ionization energy and shielding effect.

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Ans. Hydrogen (H), Lithium (Li), Sodium (Na), Potassium (K), Rubidium (Rb), Cesium (Cs) and Fransium (Fr).

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Ans. There are five elements in group 17 called halogens named as fluorine (F), Chlorine (Cl), bromine (Br), iodine (I) and astatine (At). Bromine is found in liquid state.

3.2 PERIODICITY OF PROPERTIES

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Ans. The half of the distance between the nuclei of the two bonded atoms is referred as the atomic radius of the atom.

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Ans. Pico meter (pm) = 10^{-12}

Nano meter (nm) = 10^{-9}

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Q.4 Define ionization energy.

Ans. The ionization energy is the amount of anergy required to remove the most loosely bound electron from the valence shell of an isolated gaseous atom.

Q.5 Why the 2nd ionization energy of an elements is higher than first one?

Ans. The energy required to remove an electron from an isolated monopositive gaseous ion (M+) is called second ionization energy.

So, more energy is required to remove 2nd electron from a monopositive gaseous ion because there is more electrostatic force present between the nuclei and electron.

$$M^{+}_{(g)} \longrightarrow M^{+}_{(g)} + e^{-}$$

Q.6 What is trend of ionization energy in a group?

Ans. As we move down the group more and more shells lie between the valence shell and the nucleus of the atom, these additional shells reduce the electrostatic force felt by the electrons present in the outermost shell. Resultantly the valence shell electrons can be taken away easily.

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Ans. The ionization energy of sodium is less than the magnesium because sodium has one electron, in its valence shell, while magnesium has two electrons in its valence shell, so, there is more electrostatic force between the electrons of "Mg" with nucleus as compare to one electrons of sodium.

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Ans. it is difficult to remove an electron from halogens because, they have seven electrons in their valence shell. The high ionization energy is required to remove an electron from their valence shell.

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Ans. The electrons present between the nucleus and the outermost shell of an atom, reduce the nuclear charge felt by the electrons present in the outermost shell. The attraction of outer electrons towards nucleus is partially reduced because of inner electrons. As a result an atom experiences less nuclear charge than that of the actual charge, which is called effective nuclear charge (Z_{eff}).

Q.11 Why does the bigger size atoms have more shielding effect?

Ans. In bigger size atoms the number of inner shells and inner shell electrons increases hence the shielding effect of bigger size molecules also increases.

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Ans. From left to right electron affinity and electronegativity increases because when the size of atom decreases the attraction of nucleus for electrons also increases. It means the more nuclear force on electrons the more energy is required. Therefore, electronegativity values also increases from left is right in the periodic table.

Q.13 Which element has the highest electronegativity?

Ans. Fluorine (F) atom has the highest electronegativity value among all the elements. It has value of electronegativity is 4.00.

LONG QUESTIONS

Introduction

In nineteenth century chemists devoted much of their efforts in attempts toarrange elements in a systematic manner. These efforts resulted in discovery of periodic law. On the basis of this law, the elements known at that time, were arranged in the form of a table which is known as periodic table. One of the significant features of the table was that it predicted the properties of those elements which were not even discovered at that time. The vertical columns of that table were called groups and horizontal lines were called periods. That orderly arrangement of elements generally coincided with their increasing atomic number. The periodic table contains huge amount of information for scientists.

Q. No. 1 What is law of triads? Write down its draw backs.

DOBEREINER'S TRIADS

Statement

A German chemist Dobereiner observed relationship between atomic masses of several groups of three elements called triads. In these groups the central or middle element had atomic mass average of the other two elements.

Example

One triad group example is that of calcium (40), strontium(88) and barium (137). The atomic mass of strontium is the average of the atomic masses of calcium and barium.

Drawbacks

- Only a few elements could be arranged in this way.
- This classification did not get wide acceptance.

Cannizzaro

After successful determination of correct atomic masses of elements by Cannizzaro in 1860, attempts were again initiated to organize elements.

Q. No. 2 What is law of Octaves? Write down its draw backs.

NEWLANDS OCTAVES

Introduction

In 1864 British chemist Newlands put forward his observations in the form of 'law of octaves'.

Statement

He noted that there was a repetition in chemical properties of every eighth element if they were arranged by their increasing atomic masses He compared it with musical notes.

Drawbacks

- His work could not get much recognition as no space was considered for undiscovered element.
- The noble gases were also not known at that time.

Q. No. 3 Explain the Mendeleeve's periodic table. Write down its demerits.

MENDELEEV'S PERIODIC TABLE

Introduction

Russian chemist, Mendeleev arranged the known elements (only 63) in order of increasing atomic masses, in horizontal rows called periods. So that elements with similar properties were in the same vertical columns. This arrangement of elements was called Periodic Table.

Mendeleev's Periodic law.

"Properties of the elements are periodic functions of their atomic masses"

Demerits

- Did not explain the position of isotopes.
- Wrong order of the atomic masses of some elements suggested that atomic mass of an element cannot serve as the basis for the arrangement of elements.

Q. No. 4 What is modern periodic law?

MODERN PERIODIC LAW

Introduction

In 1913 H. Moseley discovered a new property of the elements i.e. atomic number. He observed that atomic number instead of atomic mass should determine the position of element in the periodic table

The periodic law

"Properties of the elements are periodic function of their atomic numbers".

Note

Atomic number of an element is equal to the number of electrons in neutral atom. So atomic number provides the basis of electronic configurations well.

> **DO YOU KNOW**
>
> Atomic number is a more fundamental property than atomic mass because atomic number of every element is fixed and it increases regularly by 1 from element to element. No two elements can have the same atomic number.

Q. No. 5 Why modern periodic table is based upon atomic number and periodicity?

MODERN PERIODIC TABLE

Atomic number of an element is more fundamental property than atomic mass

- It increases regularly from element to element.
- It is fixed for every element.
- So the discovery of atomic number of an element in 1913 led to change in Mendeleev's periodic law which was based on atomic mass.

The modern periodic table is based upon periodicity

The modern periodic table is based upon the arrangement of elements according to increasing atomic number. When the elements are arranged according to increasing atomic number from left to right in a horizontal row, properties of elements were found repeating after regular intervals such that elements of similar properties and similar configuration are placed in the same group. It was observed that after every eighth element, ninth element had similar properties to the first element.

Example

Sodium (Z=11) had similar properties to lithium (Z=3). After atomic number 18, every nineteenth element was showing similar behavior. So the long rows of elements were cut into rows of eight and eighteen elements, and placed one above the other so that a table of vertical and horizontal rows was obtained.

Q. No. 6 What is the significance of atomic number in modern periodic table?

LONG FORM OF PERIODIC TABLE

The significance of atomic number

The significance of atomic number in the arrangement of elements in the modem periodic table lies in the fact that as electronic configuration is based upon atomic number, so the arrangement of elements according to increasing atomic number shows the periodicity (repetition of properties after regular intervals) in the electronic configuration of the elements that leads to periodicity in their properties. Hence the arrangement of elements based on their electronic configuration created a long form of periodic table

Q. No. 7 Define Periods. Write down its properties.

PERIODS

Definition

The horizontal rows of elements in a periodic table are called periods.

Properties

- The elements in a period have continuously increasing atomic number i.e. continuously changing electronic configuration along a period.
- As a result properties of elements in a period are continuously changing.
- The number of valence electrons decides the position of an element in a period.

Example

- Elements which have 1 electron in their valence shell occupies the left most position in the respective periods, such as alkali metals.
- Similarly the elements having 8 electrons in their valence shells such as noble gases always occupy the right most position in the respective periods.

Q. No. 8 Define Groups. Write down its properties.

GROUPS

Definition

The vertical columns in a periodic table are called groups.

Properties

- These groups are numbered from left to right as 1 to 18.
- The elements in a group do not have continuously increasing atomic numbers.
- Rather the atomic numbers of elements in a group increase with irregular gaps.
- But the elements of a group have similar electronic configuration i.e. same number of electrons are present in the valence shell.

Example

- The first group elements have only electron in their valence shells.
- Similarly group 2 elements have 2 electrons in their valence shells.

Note

It is the reason elements of a group have similar properties.

Q. No. 9 Write down Salient Features of Long Form of Periodic Table.

Salient Features of Long Form of Periodic Table

- This table consists of seven horizontal rows called periods
- First period consists of only two elements. Second and third period consist of 8 elements each. Fourth and fifth period consist of 18 elements each. Sixth period has 32 elements while seventh period has 23 elements and is incomplete.
- Elements of a period show different properties.

- There are 18 vertical columns in the periodic table numbered 1 to 18 from left to right, which are called groups.
- The elements of a group show similar properties.
- Elements are classified into four blocks depending upon the type of the sub- shell which gets the last electron.

Fig. 3.1 Modern Periodic Table or long form of the Periodic Table of Elements.

Q. No. 10 Explain the block wise distribution of elements in modern period table.

Blocks in the periodic table

- On the basis of completion of a particular sub shell, elements with similar sub shell electronic configuration are referred as a block of elements.
- There are four blocks in the periodic table named after the name of the sub shell which is in the process of completion by the electrons.
- These are s, p, d and f blocks

Example

- Elements of group 1 and 2 have valence electrons in 's' sub shell. Therefore, they are called s-block elements.
- Elements of group 13 to 18 have their valence electrons in 'p' sub shell. Therefore, they are referred as p-block elements.
- The d-block lies between the s and p blocks.
- While f-block lies separately at the bottom. d-block constitutes period 4,5 and 6. Each period consists of ten groups starting from group 3 to group 12. These are called transition metals.

DO YOU KNOW

Alchemy! For thousand years alchemy remained field of interest for the scientists. They worked with two main objectives; change common metals into gold and second find cure to diseases and give eternal life to people. They believed all kinds of matter were same combination of four basic elements. Substances are different because these elements combine differently. Changing composition or ratio of anyone element, new substances can be formed. The way of making gold from silver or lead was never found and secret of eternal life was never discovered. However, many methods and techniques invented by alchemists are still used in chemistry.

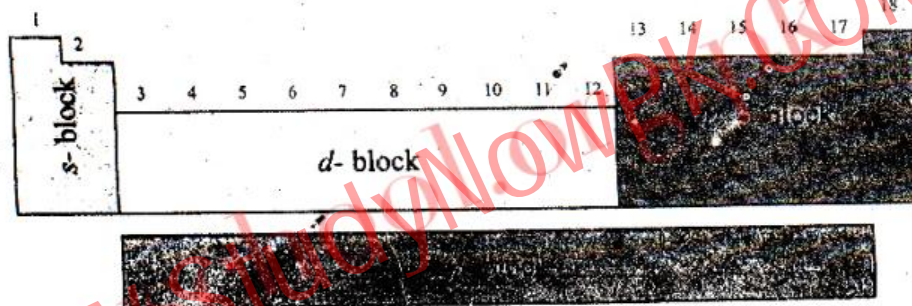



Fig. 3.2 Modern Periodic Table showing four blocks.

Q. No. 11 Write in detail the periods in periodic table.

Periods

- First period is called short period. It consists of only two elements, hydrogen and helium.
- Second and third periods are called normal periods. Each of them has eight elements in it. Second period consists of lithium beryllium, boron, carbon, nitrogen, oxygen, fluorine and ends at neon, a noble gas.
- Fourth and fifth periods are called long periods. Each one of them consists of eighteen elements.
- Sixth and seventh periods are called very long periods. In these periods after atomic number 57 and 89, two series of fourteen elements each, were accommodated. Because of space problem, these two series were placed separately below the normal periodic table to keep it in a manageable and presentable form. Since the two series start after Lanthanum (Z=57) and Actinium (Z=89), so these two series of elements are named as Lanthanides and Actinides respectively.

- All the periods except the first period start with an alkali metal and end at a noble gas.
- It is to be observed that number of elements in a period is fixed because of maximum number of electrons which can be accommodated in the particular valence shell of the elements.

Period No.	Name of the Period	Number of Elements	Range of Atomic Numbers
1st	Short Period	2	1 to 2
2nd	Normal Period	8	3 to 10
3rd		8	11 to 18
4th	Long Period	18	19 to 36
5th		18	37 to 54
6th	Very Long Period	32	55 to 86
7th		[23]*	87 to 118*

Q. No. 12 Write in detail the groups in periodic table.

3.1.2 Groups

- Group 1 consists of hydrogen, lithium, sodium, potassium, rubidium, cesium and francium.
- Although elements of a group do not have continuously increasing atomic numbers, yet they have similar electronic configuration in their valence shells. Elements of group are also called family.

Example

- All the group 1 elements have one electron in their valence shells, they are given the family name of alkali metals
- The groups 1 and 2 and 13 to 17 contain the normal elements.
- In the normal elements, all the inner shells are completely filled with electrons, only the outermost shells are incomplete.
- Group 17 elements (halogens) have 7 electrons in their valence (outermost) shell.
- The groups 3 to 12 are called transition elements. In these elements 'd' sub- shell is in the process of completion.

Valence electrons	Group number	Family name	General Electronic configuration
1 electron	1	Alkali metals	ns^1
2 electrons	2	Alkaline earth metals	ns^2
3 electrons	13	Boron family	$ns^2\ np^1$
4 electrons	14	Carbon family	$ns^2\ np^2$
5 electrons	15	Nitrogen family	$ns^2\ np^3$
6 electrons	16	Oxygen family	$ns^2\ np^4$
7 electrons	17	Halogen family	$ns^2\ np^5$
8 electrons	18	Noble gases	$ns^2\ np^6$

DO YOU KNOW

Beautiful fireworks display are common on celebrations like Pakistan Day or even on marriages. A technology invented in China is used a ll over the world. It is dangerous but careful use of various elements and particularly metal salts of different composition give beauty and colors to the fireworks. Elements like magnesium, Aluminium are used in powdered form. Salts of sodium give yellow color, calcium - red; strontium-scarlet; barium-green and copper-bluish green. Usually nitrates and chlorates are used. Other chemicals are added to give brilliance and different shades. Because of fire hazard and risk to life and property, only skilled professionals use them.

Q. No. 13 What is atomic size? Write down its trend in modern periodic table.

ATOMIC SIZE

Definition

The half of the distance between the nuclei of the two bonded atoms is referred as the atomic radius of the atom.

Example

The distance between the nuclei of two carbon atoms in its elemental form is 154 pm, its means its half 77 pm is radius of carbon atom.

Trend along period

When we move from left to right in a period although atomic number increases yet the size of atoms decreases gradually.

Reason

It is because with the increase of atomic number, the effective nuclear charge increases gradually because of addition of more and more protons in the nucleus. But on the other hand addition of electrons takes place in the same valence shell i.e. shells do not increase. There is gradual increase of effective nuclear charge which increases due to addition of protons. This force pulls down or contracts the outermost shell towards the nucleus.

Example

Atomic size in period 2 decreases from Li (152 pm) to Ne (69 pm)

154(pm)
2r
r
77(pm)

Fig. 3.3 The radius of carbon atom.

Trend along group

The size of atoms or their radii increases from top to bottom in a group.

Reason

It is because a new shell of electrons is added up in the successive' period, which decreases the effective nuclear charge.

Q. No. 14 What is shielding effect? Write down its trend in modern periodic table.

SHIELDING EFFECT

Definition

The electrons present between the nucleus and the outer most shell of an atom reduce the nuclear charge felt by the electrons present in the outermost shell.

Effective nuclear charge

The attraction of outer electrons toward nucleus is partially reduced because of presence of inner electrons. As a result an atom experiences less nuclear charge than that of the actual charge, which is called effective nuclear charge (Z_{eff}).

Explanation

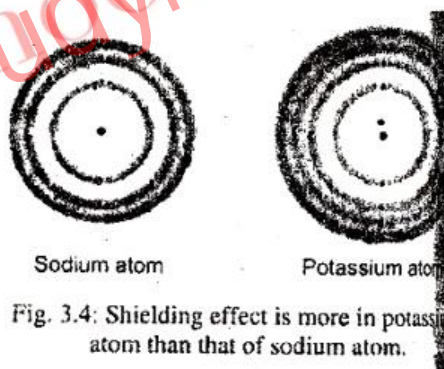
It means that the electrons present in the filled energy levels screen or shield the force of attraction of nucleus felt by the valence shell electrons. This is called shielding effect. With increase of atomic number, the number of electrons in an atom also increases, that results in increase of shielding effect.

Trend along group .

The shielding effect increases down the group in the periodic table. Because of this it is easy to take away electron from Potassium (Z=19) than from Sodium (Z=11) atoms.

Trend along period

Similarly the shielding effect decreases in a period if we move from left to right.

Fig. 3.4: Shielding effect is more in potassi atom than that of sodium atom.

Q. No. 15 What is ionization energy? Write down its trend in modern periodic table.

IONIZATION ENERGY

Definition

The ionization energy is the amount of energy required to remove the most loosely bound electron from the valence shell of an isolated gaseous atom.

First Ionization Energy

The amount of energy needed to remove successive electrons present in an atom increases. If there is only 1 electron in the valence shell, the energy required to remove it will be called first ionization energy.

Example

The first ionization energy of sodium atom is + 495.8 $kJmol^{-1}$

Trend along group

Ionization energy of elements decreases from top to bottom in a group.

Reason

As we move down the group more and more shells lie between the valence shell and the nucleus of the atom, these additional shells reduce the electrostatic force felt by the electrons present in the outermost shell. Resultantly the valence shell electrons can be taken away easily. Therefore, ionization energy of elements decreases from top to bottom in a group.

Ionization energy value depends upon number of electrons in valence shell

But when there is more than one electron in the valence shell, they can be removed one by one by providing more and more energy. Such as group 2 and 3 elements have more than one electron in their shells. Therefore, they will have more than one ionization energy values.

1st group elements	Ionization (kJmol^{-1})
3Li	520
11Na	496
19K	419
37Rb	403
55Cs	377

Trend along period

If we move from left to right in a period, the value of ionization energy increases.

Reason

It is because the size of atoms reduces and valence electrons are held strongly by the electrostatic force of nucleus. Therefore, elements on left side of the periodic table have low ionization energies as compared to those on right side of the periodic table.

2nd period elements	3U	48e	58	6C	7N	80	9F	10Ne
Ionization energy (kJmol-1)	520	899	801	1086	1402	1314	1681	2081

As we move down the group more and more shells lie between the valence shell and the nucleus of the atom, these additional shells reduce the electrostatic force felt by the electrons present electron scan be taken away easily. Therefore, bottom in a group.

Q. No. 16 What is electron affinity? Write down its trend in modern periodic table.

ELECTRON AFFINITY

Definition

Electron Affinity is defined as the amount of energy released when an electron is added up in the outermost shell of an isolated gaseous atom.

Affinity means attraction. Therefore, electron affinity means tendency of an atom to accept an electron to form an anion.

Example

The electron affinity of fluorine is -328 kJ mol^{-1} i.e. one mole atom of fluorine release 328 kJ of energy to form one mole of fluoride ions.

Trend of electron affinity along period

Electron affinity values increase from left to right in the period. .

Reason

The reason for this increase is, as the size of atoms decreases in a period, the attraction of the nucleus for the incoming electron increases. That means more is attraction for the electron, more energy will be released.

Trend of electron affinity along group .

In a group electron affinity values 17th group Electron affinity decrease from top to bottom because the size of elements (kJmol^{-1})atoms increases down the group.

Reason

With the increase in size of atom shielding effect increases that result in poor attraction for the incoming electron i.e. less energy is released out. For example, as the size of iodine atom is bigger than chlorine, its electron affinity is less than iodine.

2nd period elements	3Li	4Be	5B.	6C	7N	8O	9F	10Ne
Electron affinity (kJmol-1)	-60	>0	-29	-122	0	-141	-328	0

Q. No. 17 What is electro negativity? Write down its trend in modern periodic table.

ELECTRO NEGATIVITY

Definition

The ability of an atom to attract the shared pair of electrons towards itself in a molecule! is called electro negativity.

Condition

It is an important property especially when covalent type of bonding of elements is under consideration.

Trend of electro negativity along period

The trend of electro negativity is same as of ionization energy and electron affinity. It increases in a period from left to right.

Reason

Because higher (Z_{eff}) shortens distance from the nucleus of the shared pair of electrons. Thus, enhances the power to attract the shared pair of electrons.

Example

Electro negativity values of group 2 are given as follows:

Trend of electro negativity along group

It generally decreases down a group because size of the atom increases. Thus attraction for the shared pair of electrons weakens. For example, electro negativity values of group 17 (halogens) are presented here.

17111 group elements	Electro negativity
$_{9}F$	4.0
$_{17}Cl$	3.2
$_{35}Br$	3.0
$_{53}I$	2.7

EXERCISE

MCQ'S

1. **The atomic radii of the elements in Periodic Table:**

   (a) increase from left to right in a period (b) increase from top to bottom in a group

   (c) do not change from left to right in a period (d) decrease from top to bottom in a group

2. **Mendeleev Periodic Table was based upon the:**

   (a) electronic configuration (b) atomic mass

   (c) atomic number (d) completion of a subshell

3. **Long form of Periodic Table is constructed on the basis of:**

   (a) Mendeleev Postulate (b) atomic number

   (c) atomic ~ass (d) mass number

4. **4th and 5th period of the long form of Periodic Table are called:**

   (a) short periods (b) normal periods (c) long periods (d) very long periods

5. **Which one of the following halogen has lowest electronegativity?**

   (a) flourine (b) chlorine (c) bromine (d) iodine

6. **Along the period, which one of the following decreases:**

   (a) atomic radius (b) ionization energy (c) electron affinity (d) electronegativity

7. **Transition elements are:**

   (a) all gases (b) all metals (c) all non-metals (d) all metalloids

8. **Mark the incorrect statement about ionization energy:**

   (a) it is measured in kJmor^{1} (b) it is absorption of energy

   (c) it decreases in a period (d) it decreases ina group

9. **Point out the incorrect statement about electron affinity:**

   (a) it is measured in klmol" (b) it involves release of energy

   (c) it decreases in a period (d) it decreases in a group

10. **The amount of energy given out when an electron is added to an atom is called:**

    (a) lattice energy (b) ionization energy (c) electronegativity (d) electron affinity

ANSWR KEY

1	b	3	b	5	d	7	b	9	c
2	b	4	c	6	a	8	c	10	d

SHORT QUESTIONS

Q.1 Why noble gases are not reactive?

Ans: Noble gases are not reactive because noble gases have eight electrons in their valence shells. So, they do not react with other elements. If elements do not have eight electrons in their valence shells they become reactive and by gaining or losing of electrons make them stable. But noble gases are not reactive.

Q.2 Why Cesium (at.no.55) requires little energy to release its one electron present in the outermost shell?

Cesium requires less energy to release its outermost electron because this electron is far away from nucleus. Hence, its ionization energy is very low. Because of large distance between nucleus and outermost shell it loses its electron easily.

Q.3 How is periodicity of properties dependent upon number of protons in an atom?

Ans: In periodic table, from left to right proton number increases in nucleus. Hence, nuclear charge will also change.

Q.4 Why shielding effect of electrons makes cation formation easy?

Ans: The decrease in the attractive force exerted by the nucleus on the valence shell electrons due to the presence of the electrons lying between the nucleus and valence-shell, is called shielding effect. When an element lose its one electron then its shielding effect will also increases. That's why, it loses its valence shell easily and became a cation.

Q.5 What is the difference between Mendeleev's periodic law and modem periodic law?

Ans:

Mendeleevs periodic law	Modern periodic law
Properties of the elements are periodic function of their atomic masses.	Properties of the elements are periodic function of their atomic numbers.
Atomic masses is the basic property of his law.	Atomic number is the basic property of modern periodic law.

Q.6 What do you mean by groups and periods in a Periodic Table?

Ans: The horizontal rows of elements in a periodic table are called periods. The vertical columns in a periods table are called group.

Q.7 Why and how are elements arranged in 4th period?

Ans: Eight elements are present in 4th period. Their names are

Magnesium (Mg)
Aluminium (Al)
Silicon (Si)
Phosphorus (P)
Sulphur (S)
Chlorine (Cl)
Argon (Ar)

Q.8 Why the size of atom does not decrease regularly in a period?

Ans: From left to right atomic radius decreases in a periodic table. This change is not regular because shielding effect changes. If shielding effect decreases the size will also decreases.

Q.9 Give the trend of ionization energy in a period.

Ans: The ionization energy of elements increases as we go from left to right in a period.

LONG QUESTIONS

Q.1 Explain the contributions of Mendeleev for the arrangement of elements in a Periodic Table.

Ans: See Topic Mandleev's Periodic Table.

Q.2 Show why in a 'period' the size of an atom decreases if one moves from left to right.

Ans: See trend atomic size in periodic table.

Q.3 Describe the trends of electronegativity in a period and in a group.

Ans: See trend of electro negativity in Modern periodic table.

Q.4 Discuss the important features of modem Periodic Table.

Ans: See topic salient feature of periodic table.

Q.5 What do you mean by blocks in a periodic table and why elements were placed in blocks?

Ans: See the topic modern periodic table.

Q.6 Discuss in detail the periods in Periodic Table?

Ans: See the topic period in periodic table.

Q.7 Why and how elements are arranged in a Periodic Table?

Ans: See the topic periodic table.

Q.8 What is ionization energy? Describe its trend in the Periodic Table?

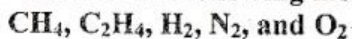
Ans: See the topic of ionization energy.

Q.9 Define electron affinity, why it increases in a period and decreases in a group in the Periodic Table.

Ans: See the topic electron infinity.

Q.10 Justify the statement, bigger size atoms have low ionization energy and have more shielding effect.

Ans: See the topic trend in ionization energy and shielding effect.

Q.11 Point out the type of covalent bonds in the following molecules
CH_4, C_2H_4, H_2, N_2, and O_2

Ans.

Single covalent bond	Double Covalent Bond	Triple Covalent Bond
CH_4	O_2	N_2
or H – C – H (with H above and H below C)	or O == O	or N≡N
	C_2H_4	
	or $H_2C == CH_2$	
H_2		
or H – H		

Q.12 What is a lone pair? How many lone pairs of electrons are present on nitrogen in ammonia?

Ans. Lone pair: the non-bonded electron pair available on an atom, like the one lone pair is available on nitrogen in ammonia is called a lone-pair. There is one lone pair of electrons in ammonia molecule on nitrogen. Lone pair $\longrightarrow$ $:NH_3$

Q.13 Why is the BF_3 electron deficient?

Ans. In the formation of BF_3 molecule, three valence electrons of boron atom (Z=5) pair up with three electrons, "one form each three fluorine atoms". The boron atom even after this sharing of electrons, remain short or deficient of two electrons in its outermost shell. If a molecule with a lone pair approaches this molecule, it accepts lone pair from that donor and forms a coordinate covalent bond.

Q.14 What types of electron pairs make a molecule good donor?

Ans. Lone pairs present on any atom make a molecule good donor. As in the case of ammonia molecule the lone pair present on nitrogen atom makes it good donor molecule to form a coordinate covalent bond.

Q.15 What is difference between bonded and lone pair of electron 'and how many bonded pair of electrons is present is NH_3 molecule?

Ans. Bonded pair of electrons are those electron pair which take part in chemical bonding. They occupy less space within the molecules than lone pairs. There are one lone pair present on a nitrogen atom in ammonia molecule. $\ddot{N}H_3$

Q.16 What do you mean by delta sign and why it develops?

Ans. The delta (δ) sign indicates partial positive or partial negative charge that is developed due to unequal sharing of shared pair or bonded pair of electrons. For Example: (δ) Delta signs in $H^{\delta+} - F^{\delta-}$ an[illegible]$^{\delta+} - Cl^{\delta-}$ shows the partial charges of these molecules.

Q.17 Why does oxygen molecule not form a polar covalent bond?

Ans. Oxygen molecule does not form a polar covalent bond because there is no electronegativity difference between oxygen atoms. Oxygen atom has six valence electrons. It requires two electrons to attain nearest noble gas electronic configuration of $_{10}Ne$.

Q.18 Why has water polar covalent bonds?

Ans. Water formed by the combination of oxygen and hydrogen atoms. The electro-negativity difference between oxygen and hydrogen atoms is maximum. When the electro-negativity difference between two covalently bonded atoms, there will be unequal attraction for the bond pair of electrons between such atoms. Due to this reason, water is polar covalent bond.